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ABSTRACT

This document is designed to present a process for reviewing, evaluating, and revising a mathematics program at the building or district level. It is organized into the following sections: 1) Philosophy and Rationale, addressing the global reasons for including mathematics in the total program; 2) Expected Outcomes, outlining expectations at the end of elementary, middle, and secondary years; 3) The Existing Program; 4) Program Evaluation, evaluating the existing program along four paramenters; 5) Available Resources; 6) Needs and Recommendations for strengthening the program; 7) Sequencing the Topics, examining the sequences for possible modification; and 8) Course Descriptions, writing new grade/course outlines. The material is designed to be helpful to both educators and concerned lay persons. (MP)

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CURRICULUM REVIEW HANDBOOK

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CURRICULUM REVIEW HANDBOOK

MATHEMATICS

1981-82

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FOREWORD

Will Rogers once said,

> "You can be on the right track and still
> get run over if you just sit there."

His words illustrate that a periodic evaluation of the mathematics curriculum is necessary for continued improvement of the total school program. This Curriculum Review Handbook for Mathematics was developed for use as a guide in such an evaluation. We hope that it will be helpful to educators and concerned lay persons throughout the state.

Leslie Fisher

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INTRODUCTION

The purpose of the Curriculum Review Handbook for Mathematics is to present a process for reviewing, evaluating, and revising a mathematics program. This process can be followed at the building or district level. This process involves:

Section I - addressing the global reasons for including mathematics in the total school program;

Section II - outlining expected student outcomes at the end of elementary years, end of middle years, and the end of secondary years;

Section III - describing the existing mathematics program;

Section IV - evaluating the existing mathematics program along four parameters;

Section V - listing resources;

Section VI - listing needs and recommendations to strengthen the mathematics program;

Section VII - examining the sequences of topics in the mathematics program for possible modification;

Section VIII - writing new grade/course outlines.

SECTION I – PHILOSOPHY AND RATIONALE

The purpose of this section is to analyze the far-reaching reasons for inclusion of mathematics in the curriculum. In responding to the questions and statements in this section, focus should be maintained on those mathematically-related attitudes, concepts and skills deemed essential to the successful adult.

A. What do we believe about the unique nature of mathematics?

1.

2.

3.

4.

5.

B. What do we believe about the students we teach?

1.

2.

3.

4.

5.

C. What do we believe about our responsibilities as educators?

1.

2.

3.

4.

5.

D. What do we believe about the ultimate purpose of education?

1.

2.

3.

4.

5.

E. Review responses to the previous questions, then explain why mathematics is included in your school's curriculum.

1. Elementary years (K-6)

2. Middle years (6-8)

3. Secondary years (9-12)

   a. Basic Math

   b. Consumer Math

   c. Vocational Math

   d. Computer Science

   e. Algebra

   f. Geometry

   g. Upper level classes

SECTION II – EXPECTED OUTCOMES

This section is designed to state realistically the expected outcomes (concepts and skills) desired for students at the conclusion of their school mathematics program. Three checkpoints (end of elementary years, end of middle years, and end of secondary years) are used to sub-divide the program. At each checkpoint, concepts and skills are considered in three categories: those unique to mathematics, those shared with other disciplines, and those considered as practical for life-long applications. Also, at each checkpoint, accomodation is made for expected concepts and skills for below average, average, and above average students. This method of structuring expected student outcomes is illustrated in Table I.

NOTE: It may be argued that the development of good attitudes towards mathematics, together with other positive personality traits, is at least of equal importance as the acquisition of certain concepts and skills. Hence, in stating desired student outcomes for the three checkpoints it may prove quite helpful also to delineate desired student attitudes and/or personality traits.

TABLE I

BASIC DESIGN FOR SUMMARY OF EXPECTED STUDENT OUTCOMES
CONCEPTS, SKILLS, AND ATTITUDES

	Below average Student	Average Student	Above average Student
End of Elementary Years	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical
End of Middle Years	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical
End of Secondary Years	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical	Concepts/Skills a. unique b. shared c. practical

Table II, which follows, is a partially-completed example of Expected Student Outcomes for an average student at the end of elementary years. Table III has not been filled in at all.

Using Tables II and III as guides, prepare outlines for each cell indicated in Table I (e.g. an outline for the end of secondary years for above average students, an outline for the end of middle years for average students, etc.).

TABLE II

EXPECTED STUDENT OUTCOMES
END OF ELEMENTARY YEARS
FOR AVERAGE STUDENTS
(A Partially Completed Example)

A. Concepts and Skills Unique to Mathematics

1. Computational facility with whole, fractional, decimal numbers (up to seven significant figures).

2. Reasonableness of a computational result.

3.

4.

B. Concepts and Skills Shared With Other Disciplines

1. Concepts and skills shared with several disciplines: averaging, graphing, ratio and proportion, reasonableness of a result . . .

2. Concepts and skills shared with SCIENCE: distance-rate-time problems, exponential notation . . .

3. Concepts and skills shared with READING: verbal problems, charts and graphs . . .

4. Concepts and skills shared with _____:

C. Practical or Life-Long Concepts and Skills

1. Estimation of computational results, measurement (length, area, volume, time, mass, costs) of regular geometric solids, suitability of measurement units . . .

2.

3.

4.

TABLE III

EXPECTED STUDENT OUTCOMES
END OF _____ YEARS
FOR _____ STUDENTS

A. Concepts and Skills Unique to Mathematics

1.

2.

3.

B. Concepts and Skills Shared With Other Disciplines

1. Concepts and skills shared with many disciplines:

2. Concepts and skills shared with _____:

3.

C. Practical or Life-Long Concepts and Skills

1.

2.

3.

4.

SECTION III – THE EXISTING PROGRAM

In this section, the existing mathematics program will be described. In part A. of this section, a list must be made of all mathematics currently being taught. In part B. each grade/course listed must be detailed by a grade/course outline, by major concepts/skills to be mastered, and by methods used for evaluating student demonstrations of mastery.

A partially completed example of an existing trigonometry course is provided after part B. (See Table IV, page _____.) This example may be used as a model in fulfilling the directives of part B.

A. List all mathematics currently being taught by grade or by course.

1. Elementary Years

2. Middle Years

3. Secondary Years

B. Describe each grade/course in detail.

1. Prepare an outline of each grade/course and insert in this handbook.

2. List the concepts and skills for each grade/course and insert in this handbook:

   a. Include concepts and skills unique to mathematics,

   b. Include concepts and skills shared with other disciplines,

   c. Include practical or life-long concepts and skills.

3. List and describe the ways in which student performance is evaluated:

   a. Include methods used during and at the conclusion of the grade/course,

   b. Properly identify standardized test instruments if used.

TABLE IV

PARTIALLY COMPLETED EXAMPLE
OF
AN EXISTING TRIGONOMETRY COURSE

1. Outline of Trigonometry

   a. The trigonometric functions
   b. Relationships among the trigonometry functions
   c. Values of the trigonometric functions for special angles
   d. Radian measure
   e. Graphs of the trigonometric functions
   f. Laws of sines and cosines
   g. Inverse trigonometric functions
   h. Logarithms of the trigonometric functions
   i. Sine, cosine, and tangent of the sum and difference of the two angles
   j. Double-angle and half-angle formulas
   k. Trigonometric identities and equations

2. Major Concepts and Essential Skills of Trigonometry

   a. Skills unique to trigonometry:
      relationships between trigonometry functions,
      law of sines and cosines, . . .

   b. Skills shared with other disciplines:
      use of logarithms in physical science,
      finding needed angles or sides (carpentry), . . .

   c. Practical or life-long skills:
      surveying, finding distances across obstacles, . . .

3. Current Methods of Evaluating Student Performances

   a. Chapter Review Tests from Trigonometry Forever by I. Will Doo Rite;

   b.

SECTION IV - PROGRAM EVALUATION

This evaluation will cover four major areas and include a summary. The areas are: A. Consideration of Basic Mathematics Skills, B. Mathematics and Careers, C. Contributions of Mathematics to the Total School Program, D. An Analysis of the Match Between Section II and the Existing Program Described in Section III, and E. A Summary of the Evaluation.

A. CONSIDERATION OF BASIC MATHEMATICS SKILLS

In 1977 the National Council of Supervisors of Mathematics published a Position Paper on Basic Mathematical Skills. This paper listed the following as the ten basic skills all students should be developing in the study of mathematics.

1. Problem Solving

   Learning to solve problems is the principal reason for studying mathematics. Problem solving is the process of applying previously acquired knowledge to new and unfamiliar situations. Solving word problems in texts is one form of problem solving, but students also should be faced with nontextbook problems. Problem-solving strategies involve posing questions, analyzing situations, translating results, illustrating results, drawing diagrams, and using trial and error. In solving problems, students need to be able to apply the rules of logic necessary to arrive at valid conclusions. They must be able to determine which facts are relevant. They should be unfearful of arriving at tentative conclusions, and they must be willing to subject these conclusions to scrutiny.

2. Applying Mathematics to Everyday Situations

The use of mathematics is interrelated with all computation activities. Students should be encouraged to take everyday situations, translate them into mathematical expressions, solve the mathematics, and interpret the results in light of the initial situation.

3. Alertness to the Reasonableness of Results

Due to arithmetic errors or other mistakes, results of mathematical work are sometimes wrong. Students should learn to inspect all results and to check for reasonableness in terms of the original problem. With the increase in the use of calculating devices in society, this skill is essential.

4. Estimation and Approximation

Students should be able to carry out rapid approximate calculations by first rounding off numbers. They should acquire some simple techniques for estimating quantity, length, distance, weight, etc. It is also necessary to decide when a particular result is precise enough for the purpose at hand.

5. Appropriate Computational Skills

Students should gain facility with addition, subtraction, multiplication, and division with whole numbers and decimals. Today it must be recognized that long, complicated computations will usually be done with a calculator. Knowledge of single digit number facts is essential, and mental arithmetic is a valuable skill. Moreover, there are everyday situations which demand recognition of, and simple computation with, common fractions.

Because consumers continually deal with many situations that involve percentage, the ability to recognize and use percents should be developed and maintained.

6. Geometry

Students should learn the geometric concepts they will need to function effectively in the three-dimensional world. They should have knowledge of concepts such as point, line, plane, parallel, and perpendicular. They should know basic properties of simple geometric figures, particularly those properties that relate to measurement and problem-solving skills. They also must be able to recognize similarities and differences among objects.

7. Measurement

As a minimum skill, students should be able to measure distance, weight, time, capacity, and temperature. Measurement of angles and calculations of simple areas and volumes are also essential.

Students should be able to perform measurement in both metric and customary systems using the appropriate tools.

8. Reading, Interpreting, and Constructing Tables, Charts, and Graphs

Students should know how to read and draw conclusions from simple tables, maps, charts, and graphs. They should be able to condense numerical information into more manageable or meaningful terms by setting up simple tables, charts, and graphs.

9. Using Mathematics to Predict

Students should learn how elementary notions of probability are used to determine the likelihood of future events. They should learn to identify situations where immediate past experience does not affect the likelihood of future events. They should become familiar with how mathematics is used to help make predictions such as election forecasts.

10. Computer Literacy

It is important for all citizens to understand what computers can and cannot do. Students should be aware of the many uses of computers in society, such as their use in teaching/learning, financial transactions, and information storage and retrieval. The "Mystique" surrounding computers is disturbing and can put persons with no understanding of computers at a disadvantage. The increasing use of computers by government, industry, and business demands an awareness of computer uses and limitations.

(Extracted from the Position Paper on Basic Mathematical Skills, published in 1977 by the National Council of Supervisors of Mathematics. Used by permission.)

Select a current mathematics grade/course described in Section III-B. In the chart below, place each concept/skill from that grade/course into the appropriate row. The chart may be expanded as necessary.

Problem Solving
Applications
Reasonableness
Estimation
Computation
Geometry
Measurement
Tables, Charts, Graphs
Prediction
Computer Literacy

1. Which areas in the previous chart are not provided for in the present grade/course?

2. State activities that could be added so that each area is more adequately provided for.

B. MATHEMATICS AND CAREERS

1. By the end of the secondary years, have students had the opportunity to attain the basic background concept/skills for the following occupations? Check those provided for and be prepared to explain how.

   (a) Plumber
   (b) Teacher
   (c) Service Station Attendant
   (d) Accountant
   (e) Clerk
   (f) Engineer
   (g) Carpenter
   (h) Mechanic

2. List occupations and vocations in your immediate community (minimum 8) not mentioned in the above list and check those for which adequate mathematics preparation is being provided. Be prepared to defend your choices.

3. Pick at random ten(10) students from your school's freshman class of eight years ago. List their present occupations and evaluate their mathematics preparation.

C. CONTRIBUTION TO THE TOTAL SCHOOL PROGRAM

1. Explain how the philosophy and rationale responses found in Section I are reflected in the present mathematics program.

2. How often do you have formal meetings to discuss curriculum within the mathematics department?

3. How often do you have formal meetings to discuss curriculum with other departments?

4. Describe eight (8) activities/projects that should be developed cooperatively between mathematics and another discipline. (Account for at least two different disciplines.)

D. GUIDELINES FOR ANALYZING A MATCH BETWEEN EXPECTED OUTCOMES IN SECTION II AND EXISTING PROGRAM IN SECTION III-B

The following guidelines are to be used for each concept/skill from each grade/course described in III-B.

State a concept/skill from Section III-B.

1. Which expected outcome(s) in Section II is (are) derived from this concept/skill?

2. Has this concept/skill been taught and mastered in a previous grade/course? If so, which grade/course?

   What method of evaluation determined the students' attainment of it?

3. State the average number of hours devoted to this concept/skill.

4. How are individual differences (average, above average, below average) accounted for in attainment of this concept/skill?

5. Are a variety of instructional modes utilized in teaching this concept/skill? (manipulative, auditory, visual) List and state proportion of time each method is used.

6. Will this concept/skill be obsolete in five (5) years?

E. SUMMARY OF THE EVALUATION

1. Review the results from A. through D.

2. Based on this review, identify three major strengths of the present program.

   a.

   b.

   c.

3. Based on this review, examine the student outcomes listed in Section II and make modifications and additions as necessary.

4. Special Note:

   Throughout this review the emphasis may have been on cognitive processes (concepts/skills). If so, list below those desirable attitudes that are fostered in the mathematics program. Consider notions such as punctuality, perseverance, consideration of others, self-management, etc. For each attitude listed, state three ways a student's demonstration of the attitude is rewarded in the mathematics classroom.

SECTION V - AVAILABLE RESOURCES

The purpose of this section is to list resources currently available for utilization in the existing program. Expand the following outline if necessary. Table V (see next page) may be reproduced and used as a model.

ELEMENTARY YEARS (K-6)

Basal textbooks
1.
2.
3.

Supplemental textbooks
1.
2.
3.

Visual supplemental materials
1.
2.
3.

Manipulative supplemental materials
1.
2.
3.

Organizations
1.
2.
3.

Resource books
1.
2.
3.

Periodicals
1.
2.
3.

Auditory supplemental materials
1.
2.
3.

Community resources
1.
2.
3.

Others
1.
2.
3.

TABLE V

RESOURCES FOR THE EXISTING PROGRAM

_____ YEARS ( )

Basal Textbooks

1.
2.
3.

Resource books

1.
2.
3.

Supplemental textbooks

1.
2.
3.

Periodicals

1.
2.
3.

Visual supplemental materials

1.
2.
3.

Auditory supplemental materials

1.
2.
3.

Manipulative supplemental materials

1.
2.
3.

Community resources

1.
2.
3.

Organizations

1.
2.
3.

Others

1.
2.
3.

SECTION VI – NEEDS AND RECOMMENDATIONS

Based on the results of the curriculum review process thus far, list needs and recommendations to strengthen the existing mathematics program. Carefully review all previous sections before beginning the list.

A. ELEMENTARY YEARS

A. Program Changes

1. For average students

2. For below average students

3. For above average students

B. Staffing

1. For average students

2. For below average students

3. For above average students

C. Facilities and Equipment

1. For average students

2. For below average students

3. For above average students

D. Materials, Supplies, and Other Resources

1. For average students

2. For below average students

3. For above average students

E. Other(s): _____

1. For average students

2. For below average students

3. For above average students

B. MIDDLE YEARS

A. Program Changes

1. For average students

2. For below average students

3. For above average students

B. Staffing

1. For average students

2. For below average students

3. For above average students

C. Facilities and Equipment

1. For average students

2. For below average students

3. For above average students

D. Materials, Supplies, and Other Resources

1. For average students

2. For below average students

3. For above average students

E. Other (s): _____

1. For average students

2. For below average students

3. For above average students

C. SECONDARY YEARS

A. Program Changes

1. For average students

2. For below average students

3. For above average students

B. Staffing

1. For average students

2. For below average students

3. For above average students

C. Facilities and Equipment

1. For average students

2. For below average students

3. For above average students

D. Materials, Supplies, and Other Resources

1. For average students

2. For below average students

3. For above average students

E. Other (s): _____

1. For average students

2. For below average students

3. For above average students

SECTION VII - SEQUENCING THE TOPICS

The purposes of this section are to examine the sequencing of the topics included in the mathematics program and to modify this sequencing if necessary. This examination and possible modification are undertaken to insure that the topics covered in each grade/course are oriented so as to contribute towards each student attaining the Expected Student Outcomes specified for one or more of the checkpoints.

To examine (and perhaps modify) the sequence, do the following:

1. Secure a long table as a workspace.
2. Obtain some oversized sheets of paper and tape, glue, or staple them together so that a single sheet about 2' x 6' is produced.
3. Extract each revised grade/course outline from this handbook and arrange these outlines in chronological sequence on the table directly above the long sheet.
4. Record the revised Expected Student Outcomes at appropriate locations on the long sheet.
5. Use Section IV-D as a guide and trace every topic covered in each grade/course. Determine:
   a. If and how each topic covered contributes to an Expected Student Outcome;
   b. Whether all topics follow a logical progression;

c. Whether all topics are arranged in an agreed progression in terms of levels of difficulty;

d. In which grade/course "readiness activities" for a topic will be provided;

e. In which grade/course each topic will be introduced;

f. In which grade/course each topic will be developed;

g. In which grade/course each topic will be mastered;

h. In which grade/course each topic will be reinforced.

6. Be prepared to discuss, cut, paste, modify, rewrite, compromise, etc. . . . But -- most importantly -- be determined to complete the task!!

As a result of this examination and possible modification, the structure for a revised mathematics program may be produced in a form such as illustrated on the opposite page.

TABLE VI

AN ILLUSTRATION OF A SCOPE AND SEQUENCE CHART

Symbols & Number Names	Terms & Definitions	Geometric Figures			Number & Numeration	Solve & Check
Numerals 0-10 Whole Numbers 1-10	Number, count, zero, one, . . . , ten First, second, last	Rectangle, circle, triangle			Matching 1-1	Solving informally
Numerals 0-50 Whole Numbers 1-50 Fraction ½	Half, whole, part Is greater than, is less than, is equal to	Closed curve Square			Place value through tens Concept of ½	Acting out
Numerals 0-100 Whole numbers 1-100 Counting by 2's to 100 Counting by 5's to 100 Counting by 10's to 100	Place value, ones, tens Fraction, thirds, fourths Number sentence	Line, point, line segment			Place value through thousands Concept of 1/10	Using trial and error
Numerals 0-1000 Whole Numbers 1-1000 Multiples of 2 Multiples of 5 Counting by 100's to 1000	Whole number Roman numeral Solve, rename Even, odd	Cone, cube, sphere			Place value through hundred-thousands	Testing reasonableness of solution

SECTION VIII - COURSE DESCRIPTIONS

The purpose of this section is to prepare and insert brief descriptions of the mathematics to be taught in each revised grade/course. An example description from the elementary years, an example from the middle years and an example from the secondary years are presented below and on the following page. Follow these examples in developing the grade/course descriptions for the revised mathematics program.

A. THIRD GRADE MATHEMATICS - AVERAGE STUDENT
(An Example Course Description)

1. Concepts/Skills Unique to Mathematics
   The sequence of skills at this grade level includes: identification of odd and even numbers, sequencing number patterns by 2's, 5's, and 10's, 4-digit place value, 3-digit addition and subtraction with regrouping, basic multiplication facts, 2-digit by 1-digit multiplication with regrouping, basic division facts, 2 digits divided by 1 digit, number properties, identification of fractional parts, determination of area and perimeter or rectangles.

2. Concepts/Skills Shared With Other Disciplines
   The following skills indicate a sharing with science in particular: Measurement in length to nearest centimeter and half-inch, telling time to 5 minutes, interpretation of bar graphs, standard liquid conversions, read Fahrenheit temperatures.

3. Concepts/Skills For Practical Life-Long Applications
   These skills are utilized in practical life situations: Story problems involving basic computational skills in real world situations, telling time to 5 minutes, choosing suitable standard and metric linear and volumetric measurement units, and making change.

B. MATHEMATICS 7
(An Example Course Description)

1. Concepts/Skills Unique to Mathematics
This course emphasizes the basic operations with fractions and decimals, place value of numbers, rounding, meaning of percents, application of percents, measurements, basic concepts in geometry, and integers.

2. Concepts/Skills Shared With Other Disciplines
Students will be able to use fractional concepts in home economics, measurement is used in science classes as well as geography, and these skills will be needed in further study of mathematics.

3. Concepts/Skills For Practical Life-Long Applications
An understanding of rounding of numbers, applications of percent, and measurement are topics that will be used in practical life situations. The skills acquired in seventh grade math are basic to a continued study of mathematics.

C. ALGEBRA II - ACCELERATED
(An Example Course Description)

1. Concepts/Skills Unique to Mathematics
This course emphasizes deductive reasoning, real number concepts and skills, linear equations, and inequalities, polynomials, and rational expressions; covers quadratic, linear, exponential, logarithmic, and trigonometric relations and functions.

2. Concepts/Skills Shared With Other Disciplines
Many of the concepts/skills taught in this course are used in other curricula. Examples: (1) logarithms in chemistry and physics, (2) use of variables in computer science. These concepts/skills are shared with other departments in cooperative efforts at science fairs, Future Business Leaders of America contests, etc.

3. Concepts/Skills For Practical Life-Long Applications
This course provides concept/skills background for occupations involving algebraic manipulations at the present level as well as the background for reaching higher levels in math in pursuant occupations involving use of more advanced mathematics. Among these occupations are: Bookkeeper, Accountant, Managers, Teachers, Doctors, Scientists, etc.

Prerequisite: B+ in Algebra I Grade levels: 11,12